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| 14. ABSTRACT This final report summarizes the accomplishments of the AASERT research supported by the AFOSR Grant F49620-96-1-0264, entitled, Non-Cooperative Target Recognition. This Grant supported the Ph.D. dissertation of Dr. William Phillips, who after graduation returned to Northrop-Grumman Corporation. He is on leave at DARPA managing a research program on advanced architectures for image and signal processing. This research effort supported the design and analysis of novel algorithms for the exploitation of Synthetic Aperture Radar (SAR) imagery. The algorithms developed under this effort facilitate the monitoring of vehicular activities, which is one of the most important SAR image exploitation problems in military applications. Several of the primary components of an exploitation system to monitor such activities have been addressed, including high-speed target detection using parallel processors, site model construction, site-model based false alarm reduction and change detection. Experiments with TESAR and MSTAR data have been conducted. | | | | | |
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1 Executive Summary

This final report summarizes the accomplishments of the AASERT research supported by the AFOSR Grant F49620-96-1-0264, entitled, Non-Cooperative Target Recognition. This Grant supported the Ph.D. dissertation of Dr. William Phillips, who after graduation returned to Northrop-Grumman Corporation. He is on leave at DARPA managing a research program on advanced architectures for image and signal processing. This research effort supported the design and analysis of novel algorithms for the exploitation of Synthetic Aperture Radar (SAR) imagery. The algorithms developed under this effort facilitate the monitoring of vehicular activities, which is one of the most important SAR image exploitation problems in military applications. Several of the primary components of an exploitation system to monitor such activities have been addressed, including high-speed target detection using parallel processors, site model construction, site-model based false alarm reduction and change detection. Experiments with TESAR and MSTAR data have been conducted.

Publications resulting from this contract are:

1. W. Phillips and R. Chellappa. SAR target detection algorithms on linear SIMD arrays. In *Proc. IEEE Int'l. Conf. on Acoustics, Speech, and Signal Processing*, pages 4101–4105, Munich, Germany, April 1997.
2. W. Phillips and R. Chellappa. Site model based exploitation of TESAR imagery. In *Proc. ATR Working Group*, pages 34–44, Huntsville, AL, October 1997.
3. W. Phillips and R. Chellappa. Target detection in SAR: Parallel algorithms, context extraction, and region adaptive techniques. In *Proc. SPIE: Algorithms for Synthetic Aperture Radar Imagery IV*, pages 76–87, Orlando, FL, April 1997.
4. S. Kuttikkad, W. Phillips, S. Mathieu-Marni, R. Meth, and R. Chellappa. Use of context for false alarm reduction in SAR automatic target recognition. In *Proc. DARPA Image Understanding Workshop*, pages 1091–1104, New Orleans, LA, May 1997.
5. W. Phillips. SAR image understanding: High-speed target detection and site-model-based exploitation. Technical Report CAR-TR-883, Center for Automation Research, University of Maryland, April 1998.

2 Accomplishments

Several fast non-Gaussian constant false alarm rate (CFAR) detectors were designed. Emphasis was given to the order statistic CFAR (OSCFAR) because of its excellent performance in the presence of interfering targets. The usefulness of histogramming in implementing the OSCFAR detector was demonstrated. It was shown that the running time of the OSCFAR detector based on histograms is competitive with the time required to compute the traditional cell-averaging CFAR. Experiments with linear SIMD arrays and standard MIMD systems indicated that the linear SIMD arrays are excellent candidates for embedded high-performance target detection. Embedded detection processors

are needed on board aircrafts where real-time detection is required for intelligent image compression and object recognition systems. Also, the small size and low power consumption of linear SIMD arrays make them ideal for embedded detection processors.

An important step in automated construction of site-models that provide contextual information for change detection algorithms is segmentation of natural terrain. We have developed a multi-resolution statistical segmentation algorithm that outperforms most other statistical segmentation algorithms on the TESAR data set. The very narrow statistical separation of the classes in the TESAR data cause many existing segmentation algorithms to perform poorly. We have shown using the TESAR data that the multi-resolution algorithm is very effective for 2-D site-model construction. We also experimented with superresolution algorithms for MSTAR imagery. The reduced speckle and improved class separation show that reforming imagery with modern spectral estimation is an attractive preprocessing step for site-model construction. Results with MSTAR data have been very encouraging.

A complete system for the exploitation of the multi-pass TESAR imagery has been developed. The system is useful when a particular site is closely monitored by frequently revisiting the site with one or more sensors. The site-model based exploitation system effectively uses the multi-pass data to monitor and detect vehicular activity. An algorithm for building site models from multiple passes over a site has also been developed. The site-model is then used for eliminating false alarms and detect changes in subsequent images.

Experimental results on change detection using TESAR imagery may be found in the dissertation of Dr. William Phillips available as Technical Report CS-TR-3891.